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METHODS OF EXTERMINATING THE TEXAS-FEVER TICK.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., July 22, 1909.

SIR: I have the honor to transmit herewith a manuscript entitled "Methods of Exterminating the Texas-fever Tick," by H. W. Graybill, scientific assistant in the Zoological Division of this Bureau.

For many years these ticks, which transmit the disease of cattle known as Texas or tick fever, have been a cause of heavy loss and a great handicap to live-stock raising in the southern part of the United States. The progress so far made, however, in the cooperative campaign by this Department and State authorities with the object of completely eradicating this pest from the country demonstrates that it is entirely possible to accomplish that result, although a number of years of hard work will be required. It is of great importance for the success of this undertaking that the efforts of the officials should be supplemented by individual work by the farmers. This paper gives simple and practical directions for exterminating the ticks, and I respectfully recommend its publication in the popular Farmers' Bulletin series.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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INTRODUCTION.

The eradication of the cattle tick (*Margaropus annulatus*) from the Southern States is a problem of prime importance to the agricultural interests of that section. Moreover, the good that would result from the elimination of the tick would not be entirely confined to the region directly concerned, and thus the matter assumes to a certain degree a national importance.

A number of valuable papers on the life history of the cattle tick, its habits, and methods for its eradication have been published by the United States Department of Agriculture and by various investigators in the States included within the infested region. Some of these publications are rather extensive and include much that is only of scientific interest, while others, of a more practical nature, are not available for general use. The present bulletin is prepared with the view of bringing together from these various sources information of practical value relating to the tick and its eradication, for the use of the farmer or stockman who has begun or who contemplates undertaking the complete extermination of this pest from his farm. Some unpublished results of investigations carried on by the writer in connection with the cooperative work between the Zoological Division of the Bureau of Animal Industry and the veterinary department of the Alabama Polytechnic Institute have also been taken into consideration.

REASONS FOR ERADICATING THE CATTLE TICK.

There are various kinds or species of ticks occurring on cattle in the Southern States, but the one that chiefly concerns us here is that commonly called the "cattle" or "Texas-fever" tick (*Margaropus annulatus*). It is the one most frequently found on cattle and is much more abundant than the other species. When the losses occasioned by this parasite are once thoroughly understood by farmers and stockmen there will be little need for arguments in favor of tick eradication. Some of the losses are not directly noticeable and consequently make little impression, while other losses properly chargeable to the tick are frequently attributed to other causes.

It is hardly necessary to emphasize the important fact that the tick is something more than a simple parasite drawing blood from its host, it being the carrier of a dangerous micro-organism or germ, which it transmits to the blood of cattle, thus causing a disease known by many names, among which are Texas fever, tick fever, splenetic fever, and murrain.[a] Without the tick there can be no Texas fever, and it is by preventing the spread of the tick beyond its natural bounds that the fever has been prevented from waging destruction among northern cattle, which are especially susceptible to the disease. In order to restrict the distribution of the tick the National and State governments maintain a quarantine line extending from the Atlantic to the Pacific coast, marking the boundary between the States or portions of States harboring this pest and those that do not. Cattle of the quarantined area can not be driven across this line, and may be shipped only in accordance with the regulations of the Secretary of Agriculture to prevent the spread of splenetic fever of cattle.

The more important losses for which the tick is responsible are as follows:

1. Deaths from tick fever among native cattle and purebred cattle imported from the North for breeding purposes.

2. Deaths of cattle north of the quarantine line from fever following the occasional accidental introduction of the tick.

3. The temporary and permanent arrest of growth and development resulting from attacks of the fever.

4. The decrease in weight and the lessened rate in putting on flesh in the case of beef cattle, and the decrease in the amount of milk produced by dairy cattle, as the result of the irritation and loss of blood occasioned by great numbers of ticks.

5. The prevention of southern breeders from exhibiting their stock in the North.

6. The decreased price that southern cattle bring on the market on account of the restrictions placed upon them.

7. The considerable expense incurred each year by the Federal Government and the infested States in establishing quarantine lines and in enforcing regulations to prevent the spread of Texas fever.

Various writers have estimated the annual loss due to the tick at from $40,000,000 to $100,000,000. These figures should be ample argument, even to the most conservative, for the eradication of the tick.

The South needs more and better live stock and a larger and better dairy industry, and these objects would both be greatly promoted by the destruction of the tick. Furthermore, the increased produc-

[a] For information as to this disease and how it is transmitted by the ticks the reader is referred to Farmers' Bulletin 258, "Texas or Tick Fever and Its Prevention."

tion of live stock, by reason of its important bearing in maintaining and improving the fertility of the soil, would be of distinct benefit in increasing the yield of field crops. An incidental though important advantage of stock raising and dairying would be found in the distribution of the farmer's income throughout the year, enabling him to live on a cash basis. It can thus be seen that the benefits which would accrue to southern agriculture from the extermination of the cattle tick would be very great and far-reaching.

LIFE HISTORY OF THE TICK.

Before methods of eradication can be carried out intelligently and successfully, it is necessary to know the life history of the tick, and the influence of temperature, moisture, and other climatic conditions on the various stages of its existence. These matters will therefore be taken up first, it being understood that whenever the term "tick" or "cattle tick" is used, it refers to the one species or kind, *Margaropus annulatus*.[a]

The usual host for this tick is the cow or ox. Frequently, however, horses, mules, deer, and sometimes even sheep serve as hosts. But none of these latter animals, with the possible exception of deer, are susceptible to tick fever, consequently they suffer from the tick as a simple parasite and not as a transmitter of disease, although they must be considered in plans for eradication.

Only a part of the development of the tick takes place on the host; the rest of the development occurs on the pasture occupied by the host.

DEVELOPMENT ON THE GROUND.

In tracing the life history of the cattle tick it will be convenient to begin with the large, plump, olive-green female tick (fig. 1), somewhat more than half an inch in length, attached to the skin of the host. During the few preceding days she has increased enormously in size as a consequence of drawing a large supply of blood.

When fully engorged she drops to the ground, and at once, especially if the weather is warm, begins to search for a hiding place on moist earth beneath leaves or any other litter which may serve as a protection from the sun and numerous enemies. The female tick may be devoured by birds or destroyed by ants, or may perish as the result of unfavorable conditions, such as low temperature, absence or excess of moisture, and many other conditions; so that many which fall to the ground are destroyed before they lay eggs.

[a] The reader desiring fuller information as to the life history of the cattle tick is referred to Bulletin 72 of the Bureau of Entomology, United States Department of Agriculture, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15 cents.

Egg laying (see fig. 2) begins during the spring, summer, and fall months in from two to twenty days, and during the winter months in thirteen to ninety-eight days. The eggs are small, elliptical-shaped bodies, at first of a light amber color, later changing to a dark brown, and are about one-fiftieth of an inch in length. As the eggs are laid they are coated with a sticky secretion which causes them to adhere in clusters and no doubt serves the purpose of keeping them from drying out. During egg laying the mother tick gradually shrinks in size and finally is reduced to about one-third or one-fourth her original size. Egg laying is greatly influenced by temperature, being retarded or even arrested by low temperatures. It is completed in from four days in the summer to one hundred and fifty-one days beginning in the fall. During this time the tick may deposit from a few hundred to more than 5,000 eggs. After egg laying is completed the mother tick has fulfilled her purpose and dies in the course of a few days.

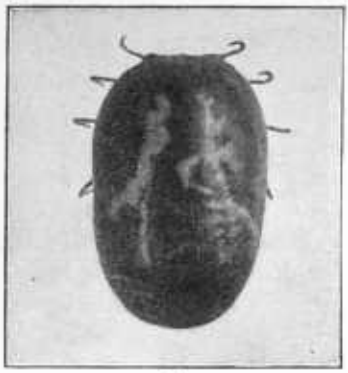
After a time, ranging from nineteen days in the summer to one hundred and eighty-eight days during the fall and winter, the eggs begin to hatch. From each egg issues a small, oval, six-legged larva or seed tick (fig. 3), at first amber colored, later changing to a rich brown. The seed tick, after crawling slowly over and about the shell from which it has emerged, usually remains more or less quiescent for several days, after which it shows great activity, especially if the weather is warm, and ascends the nearest vegetation, such as grass, other herbs, and even shrubs.

Since each female lays an enormous mass of eggs at one spot, thousands of larvæ will appear in the course of time at the same place and will ascend the near-by vegetation and collect on the leaves. This instinct of the seed ticks to climb upward is a very important adaptation to increase their chances of reaching a host. If the vegetation upon which they rest is disturbed, they become very active and extend their long front legs upward in a divergent position, waving them violently in an attempt to seize hold of a host.

The seed tick during its life on the pasture takes no food and consequently does not increase in size, and unless it reaches a host to take up the parasitic portion of its development, it dies of starvation. The endurance of seed ticks is very great, however, as they have been found to live nearly eight months during the colder part of the year.

DEVELOPMENT ON CATTLE.

The parasitic phase of development begins when the larvæ or seed ticks reach a favorable host, such as a cow. They crawl up over the hair of the host and commonly attach themselves to the skin of the escutcheon, the inside of the thighs and flanks, and to the dewlap. They at once begin to draw blood and soon increase in



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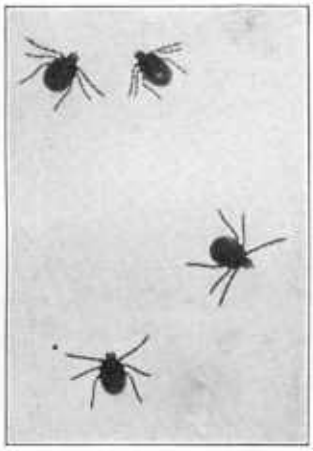

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FIGS. 1 to 7.—Cattle ticks in various stages. 1. Full-grown female tick, engorged and ready to drop to ground and deposit eggs. (Magnified 3 times.) 2. Tick laying eggs. One tick may lay as many as 5,000 eggs. (Magnified 3 times.) 3. Larvæ or seed ticks after emerging from eggs. (Magnified 9 times.) 4. Young ticks before (*a*) and after (*b*) first molt. At this stage the ticks have attached themselves to a host (cow, steer, etc.), and have changed from a brown color to white. It will be noticed that the tick has six legs before molting and eight afterwards. (Magnified 9 times.) 5. Young tick nearly ready to undergo the second molt. The tick at this stage is known as a nymph. (Magnified 6 times.) 6. Male tick. (Magnified 6 times.) 7. Female tick after second molt. This tick is now sexually mature and slightly larger than the male, but will later greatly increase in size until ready to drop to the ground and deposit eggs. (Magnified 6 times.)

size. In a few days the young tick changes from a brown color to white (fig. 4, *a*), and in from five to twelve days sheds its skin. The new form has eight legs instead of six, and is known as a nymph (fig. 4, *b*, and fig. 5).

In from five to eleven days after the first molt the tick again sheds its skin and becomes sexually mature. It is at this stage that males and females are with certainty distinguishable for the first time. The male (fig. 6) emerges from his skin as a brown, oval tick, about one-tenth of an inch in length. He has reached his growth and goes through no further development. He later shows great activity, moving about more or less over the skin of the host. The female (fig. 7) at the time of molting is slightly larger than the male. She never shows much activity, seldom moving far from her original point of attachment. She still has to undergo most of her growth. After mating the female increases very rapidly in size, and in from twenty-one to sixty-six days after attaching to a host as a seed tick she becomes fully engorged (fig. 1) and drops to the pasture, to repeat the cycle of development.

SUMMARY OF LIFE HISTORY.

To sum up, on the pasture there are found three stages of the tick—the engorged female, the egg, and the larva; and on the host are found four stages—the larva, the nymph, the sexually mature adult of both sexes, and the engorged condition of the female.

METHODS OF ERADICATION.

In undertaking measures for eradicating the tick it is evident that the pest may be attacked in two locations, namely, on the pasture and on the cattle.

In freeing pastures the method followed may be either a direct or an indirect one. The former consists in excluding all cattle, horses, and mules from pastures until all the ticks have died from starvation. The latter consists in permitting the cattle and other animals to continue on the infested pasture and treating them at regular intervals with oils or other agents destructive to ticks and thus preventing engorged females from dropping and reinfesting the pasture. The larvæ on the pasture, or those which hatch from eggs laid by females already there, will all eventually meet death. Such of these as get upon the cattle from time to time will be destroyed by the treatment, while those which fail to find a host will die in the pasture from starvation.

Animals may be freed of ticks in two ways. They may be treated with an agent that will destroy all the ticks present, or they may be rotated at proper intervals on tick-free fields until all the ticks have dropped.

TIME REQUIRED TO KILL TICKS BY STARVATION.

The time required for the ticks to die out after all animals have been removed from infested fields and pastures varies considerably, depending principally on climatic and weather conditions. The dates when pastures will be free of ticks, beginning during each month of the year, are given in the following table:

Time required to free pastures from ticks by starvation.

Date of removal of all animals from pasture.	Date when pasture will be free from ticks.	Date of removal of all animals from pasture.	Date when pasture will be free from ticks.
July 1	March 1.	December 15 to March 15, inclusive.	September 1.
August 1	May 1.	April 1	September 15.
September 1	July 1.	April 15	October 15.
October 1 to November 1, inclusive.	August 1.	May 1 to June 15, inclusive	November 1.
December 1	August 15.		

The above table is based on investigations by Hunter and Hooker [a] at Dallas, Tex., and by the writer at Auburn, Ala., under cooperation between the Bureau of Animal Industry and the veterinary department of the Alabama Polytechnic Institute. All the periods obtained by Newell and Dougherty (1906) [b] in work carried on at Baton Rouge, La., which is much farther south, are shorter. The above periods should be found ample for all localities lying no farther north than Dallas, Tex., or Auburn, Ala. The periods necessary to starve out an infestation for many localities in the southern part of the infested region are no doubt somewhat shorter than those given above. In general, moisture and cold prolong and dryness and heat shorten the duration of an infestation. If various portions of the same pasture differ with regard to temperature and moisture, as is frequently the case, some parts become free of ticks before others do. Other things being equal, high, dry, unshaded land becomes tick free sooner than low, damp, shady land.

The simplest and safest plan in most cases, however, will be to follow the foregoing table in the region indicated for it. It is probable that the periods given in the table should be lengthened a little for the northern part of the infested region. The experiments conducted thus far in various places indicate this and it will place the eradication work in that region on the safe side. For example, E. C. Cotton [c] obtained at Knoxville, Tenn., records for September and April somewhat longer than those given above. They are as follows:

Cattle removed April 15; pasture free of ticks November 13.
Cattle removed September 15; pasture free of ticks July 18.

In localities with temperature and other conditions similar to those at Knoxville, Tenn., these periods should be followed.

[a] Bulletin 72, Bureau of Entomology, U. S. Department of Agriculture.
[b] Circular 10, State Crop Pest Commission of Louisiana.
[c] Bulletin 81, Agricultural Experiment Station of the University of Tennessee.

TIME REQUIRED TO RENDER CATTLE FREE OF TICKS WHEN PLACED ON UNINFESTED FIELDS.

Before discussing plans for rendering farms tick-free, involving the use of the information given in the foregoing table, it will be necessary to indicate how animals may be entirely freed from ticks by placing them on uninfested fields. This is based on the fact that the female tick must drop from the host to the ground before eggs can be laid and before young ticks will develop.

The shortest time in which seed ticks will appear after engorged females have been dropped is twenty days. Consequently cattle placed on a tick-free field during the warmer part of the year are not in danger of becoming infested again with young ticks until twenty days have elapsed. The time required for all the ticks to drop after cattle have been placed on uninfested land varies with the temperature. It is much longer during the winter than during the summer. The time required, beginning at various times of the year, is given in the following table:

Time required for all ticks to drop from cattle placed on tick-free land.

When ticky cattle are placed on tick-free land during—	All ticks will have dropped in—	When ticky cattle are placed on tick-free land during—	All ticks will have dropped in—
August	Six weeks.	March	Seven weeks.
September	Do.	April	Six weeks.
October	Eight weeks.	May	Do.
November	Nine weeks.	June	Do.
January	Ten weeks.	July	Five weeks.
February	Seven weeks.		

FREEING CATTLE OF TICKS BY ROTATION ON TICK-FREE LAND.

The plan of freeing cattle of ticks by rotating them from one lot or field to another is as follows: Beginning at any time of the year from February to September, inclusive, the cattle are removed from the tick-infested pasture they have been occupying to a tick-free lot or field, and continued there for not more than twenty days. During this time a considerable number of ticks will drop. In order to prevent the cattle from becoming reinfested (by seed ticks resulting from eggs laid by females that have dropped), the herd is then changed to a second tick-free inclosure for twenty days longer, and if they are not free of ticks by that time they are placed in a third tick-free inclosure for twenty days more. Should the two changes at intervals of twenty days have been made, sixty days will have elapsed, which is ample time for all ticks to have dropped during the portion of the year indicated, and the animals are ready to be placed on a tick-free pasture or field without danger of becoming reinfested. The periods to free cattle (given in the above table) are believed to

be ample. It will, however, be a wise precaution to make a careful examination of the cattle for ticks before placing them in the non-infested field they are to occupy.

During the part of the year from October to January, inclusive, the time required for seed ticks to appear after females have dropped is much longer than the time necessary for all the ticks to drop from cattle. Consequently, if it is desired, the herd may be continued on the same field for the required length of time without danger of becoming reinfested.

FREEING BOTH CATTLE AND PASTURES OF TICKS BY THE ROTATION METHOD.

The particular scheme of rotation to be followed on a farm depends much on the conditions which have to be met. In figures 8 to 11 four plans of rotation are represented. In these diagrams no attempt has been made to indicate, except in a very rough way, the relative size of the fields, since this depends on the number of cattle and on various conditions of a more or less local nature. It rests with the farmer to select his fields with regard to location and size so as to carry out properly and successfully the plan which he adopts.

The matter of the dissemination of ticks deserves particular attention in considering rotation methods. The engorged females which drop on a pasture will crawl at most only a few feet. The same may be said of the larvæ or seed ticks. It is possible, however, for seed ticks to be passively carried considerable distances at times. Dogs, cats, and other animals which ordinarily pass unhindered over farms may become covered with seed ticks while going through one field, and later some of these may be brushed off the animal while passing through the herbage of an adjoining field. Even though the danger of ticks being spread in this manner is not great, it will be well, when practicable, to take precautions against it.

Again, engorged females, eggs, and seed ticks may be carried by running water from a pasture without being injured in any way. The danger from this source is probably greatest where there are many small streams subject to frequent floods of short duration and on hillsides where the water runs off with great force during heavy rains. This will, no doubt, in some localities present a rather serious problem in tick eradication.

Ticks may crawl from the edge of one pasture into an adjoining pasture, or engorged females may drop from the heads of animals reaching through a dividing fence. These difficulties are best overcome by constructing a double fence with an intervening space of 15 feet. Such a double fence, if the land does not slope greatly, will also greatly reduce the danger of ticks being washed from one pasture to the other during rains.

Plan requiring four and one-half months.—The plan of rotation represented in figure 8 requires four and a half months for its completion. Some time during the spring the pasture is divided in the middle by two lines of temporary fence 15 feet apart. The herd is first confined in field No. 1A. On June 15 it is moved from this portion of the pasture to the other portion, designated field No. 1B, and on September 2 is moved to field No. 2A. The cattle are permitted to remain twenty days on each of the fields designated 2A, 2B, and 3. At the end of this time (November 1) all the ticks on the cattle have dropped, and the herd is returned to field No. 1A, which in the meantime has become free of ticks. Later, if it is desired, the cattle may be placed in field No. 4. They should not, however, be returned to any of the other fields or driven across them, since these are infested with ticks. Field No. 1B will be free from ticks July 1 of the following year, at which time the temporary double fence may be removed and the cattle allowed to graze over the entire pasture. The rest of the farm will be free of ticks by August 1. If found desirable, the herd may be continued longer in field No. 3, even as late as February 15, the only objection to this being that it will break the crop rotation by preventing the sowing of oats in the fall.

It is well, when practicable, to have double fences with an intervening space of 15 feet between the different fields in order to prevent the ticks getting from one field to another. If this is not possible on account of the expense and time required to build the extra line of fence, the next best thing is to throw up with a plow several furrows on each side of the dividing fences.

When there are streams running through the farm or the slope of the land is considerable, so that ticks may be washed from one field to the other during rains, the fields should be so arranged or selected that the drainage is from field No. 1A to No. 1B, and from field No. 3 toward fields Nos. 2A and 2B.

Plan requiring eight months.—The plan indicated in figure 9 is begun fifteen days later than the preceding one and requires eight months for its completion. The pasture is divided as before. The herd is moved July 1 from field No. 1A to No. 1B, and on October 15 is moved from there to field No. 2. The herd may be continued on fields Nos. 2 and 3 until February 15 in any way found most convenient, since there is no danger of young ticks hatching during that time. The herd is moved not later than February 15 to field No. 4. All the ticks on the cattle will have dropped by December 20, consequently the herd may be moved to field No. 4 as early as that date, if found desirable.

By March 1 the original pasture is free and the cattle are returned there. Field No. 1B will be free of ticks by August 1, at which time

the double fence separating the two parts of the pasture may be removed. The rest of the farm will not be certainly free of ticks until September 1. The drainage in general should be from field No. 1A toward No. 1B, and from field No. 4 toward field No. 2.

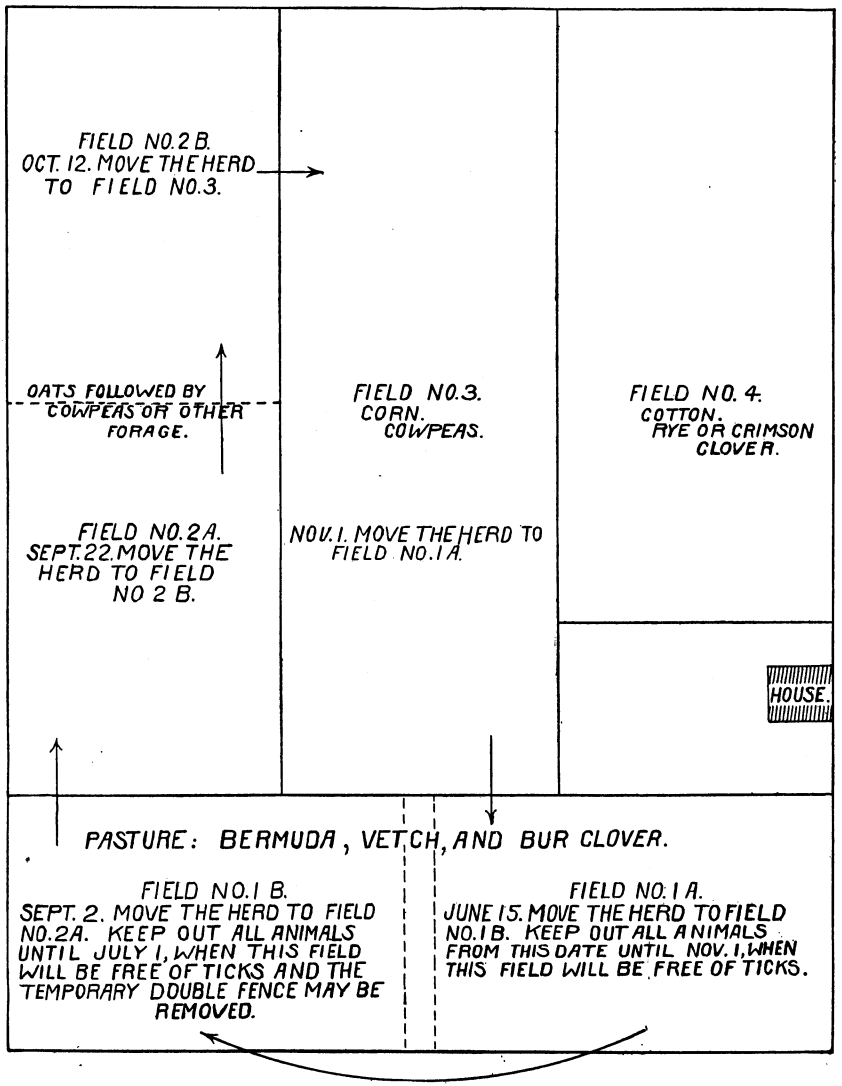

FIG. 8.—Plan for freeing cattle and pastures from ticks by rotation, requiring four and one-half months.

Plan requiring four months, with a new pasture.—The plan of rotation represented in figure 10 involves changing the location of the pasture. The oat field (field No. 4) after the grain has been harvested is reserved for this purpose. It should be sown in cowpeas, Bermuda

grass, and bur clover. The herd is moved October 15 from the original pasture, field No. 1, to field No. 2, where it may be kept for a month or two, or until the feed becomes short, then moved to field No. 3, where it is kept until February 15, when it is moved to the

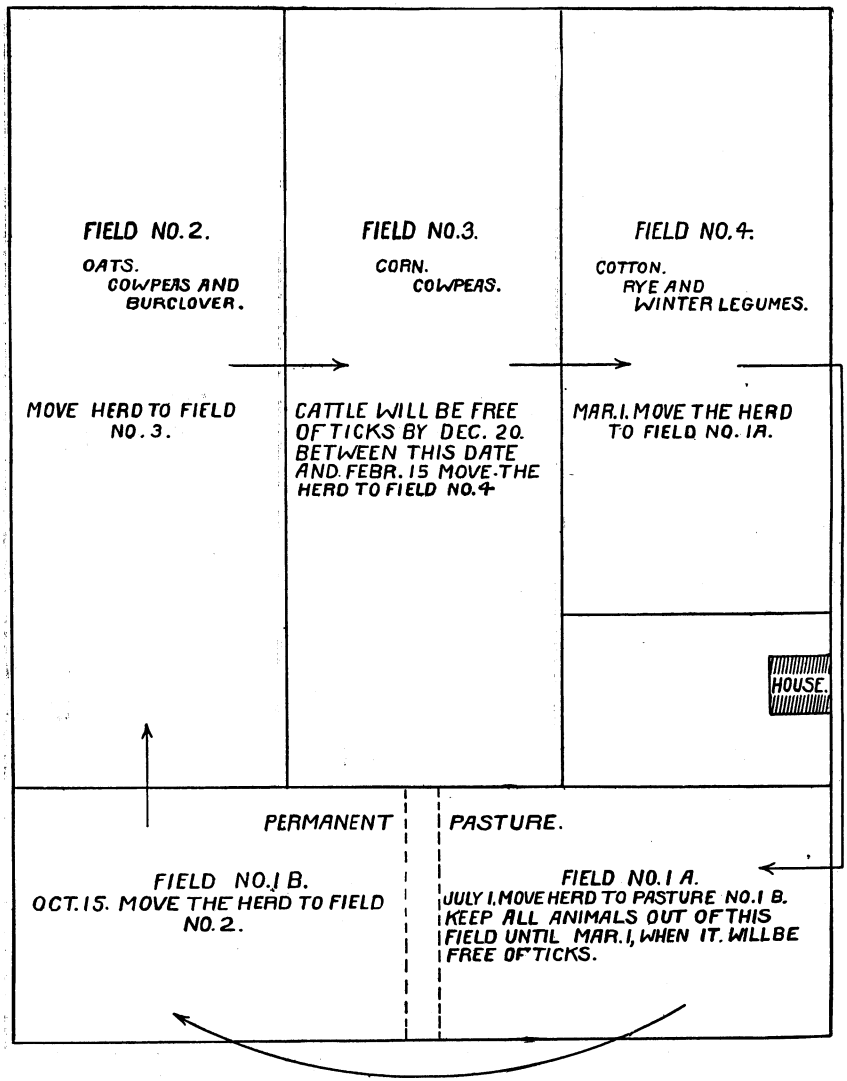

FIG. 9.—Plan for freeing cattle and pastures from ticks by rotation, requiring eight months.

new pasture, field No. 4. The old pasture may be planted in oats. The drainage should be from field No. 4 toward field No. 2.

The feed-lot or soiling method, requiring four and one-half months.—In the plan given in figure 11 the feed-lot or soiling method is made

use of to free the cattle of ticks. In the spring field No. 3B, located near the farmyard, is sown in corn for a soiling crop. The area devoted to corn should be sufficient to supply feed for the herd for five or six weeks. Field No. 3A, after the oats are harvested, should be

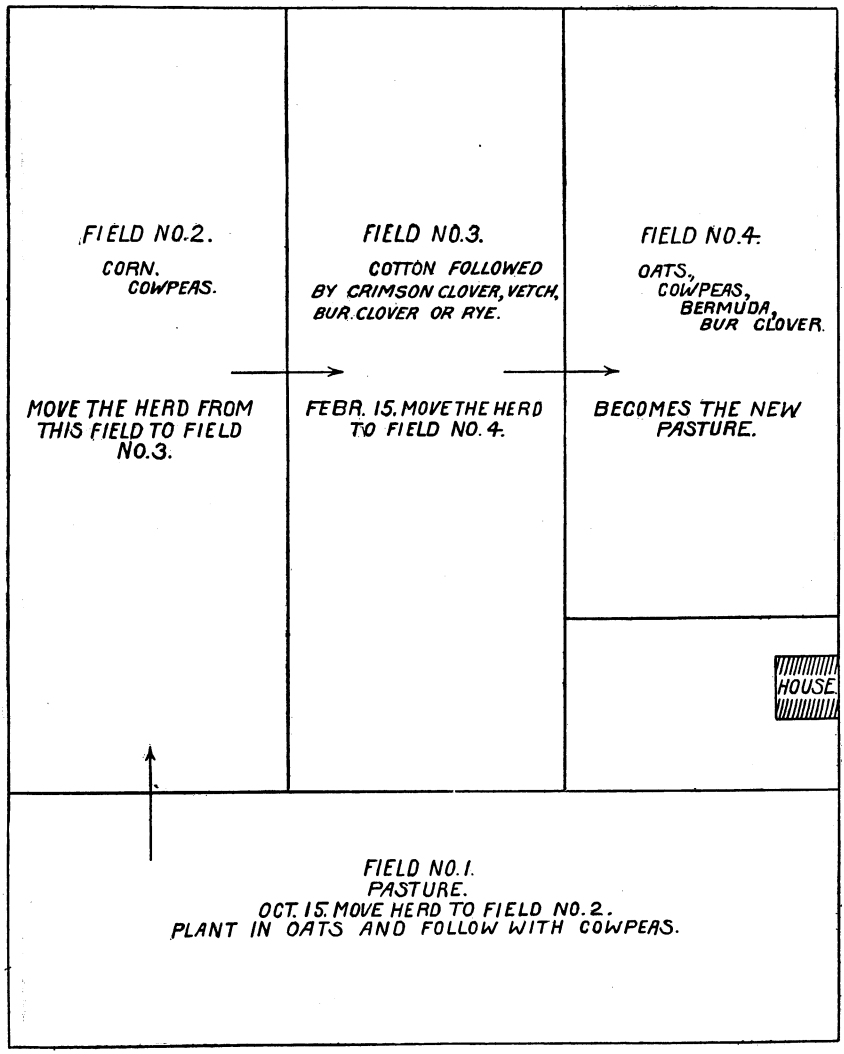

FIG. 10.—Plan for freeing cattle and pastures from ticks by rotation, requiring four months, with new pasture.

sown in sorghum and cowpeas or millet and cowpeas, and should be large enough to furnish feed for the herd until November 1. These fields should not have had cattle on them for at least ten months.

Previous to June 15 three lots, each large enough to accommodate the herd, are fenced off in field No. 3B. These lots should not be

located on a stream, and the drainage should be from field No. 3A toward field No. 3B. There should be a space of 15 feet or more between the lots. On June 15 the herd is moved to lot No. 1, and afterwards to lots Nos. 2 and 3 at intervals of twenty days. After the cattle have spent the required time in lots Nos. 1 and 2, if it is found

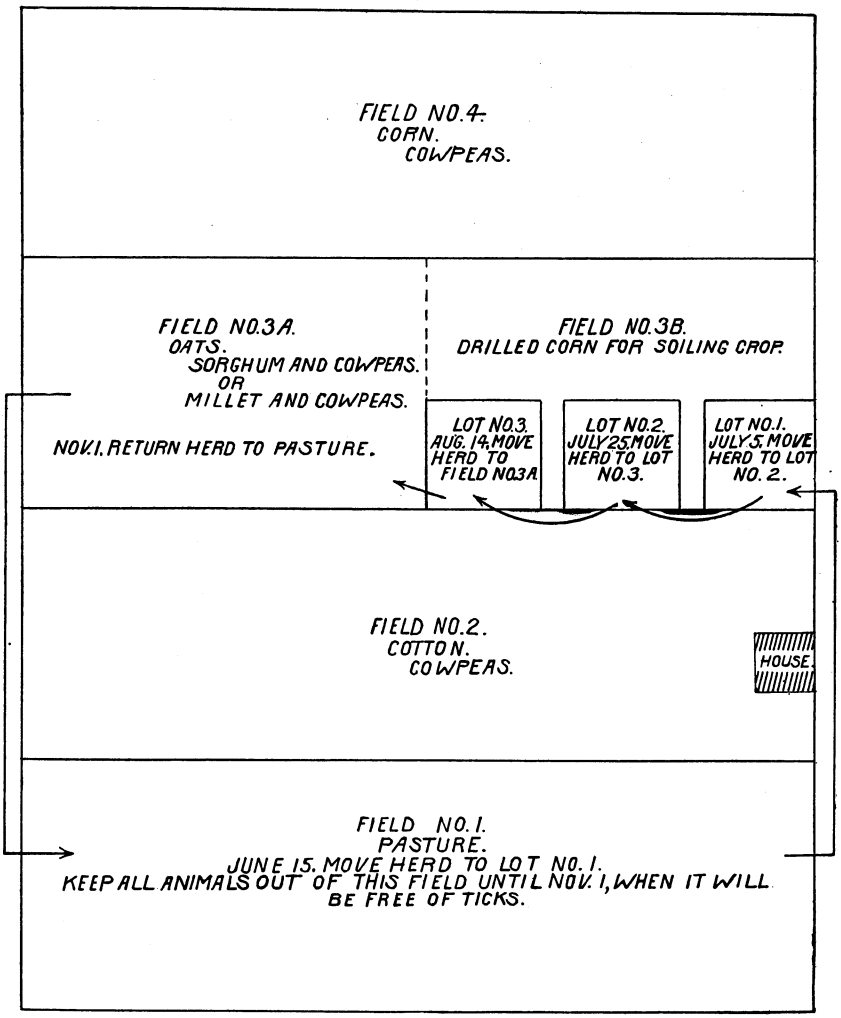

FIG. 11.—Plan for freeing cattle and pastures from ticks by rotation; feed-lot or soiling method.

after a careful examination made by some one familiar with such work that the cattle are free of ticks, they may be turned directly into field No. 3A. If they are not free they should be placed in lot No. 3 until they are free, or, if this can not be determined with certainty, until fifteen or twenty days more have elapsed, which will be much longer than necessary for all ticks to drop during July and August.

If desirable, the corn in each lot may be cut and removed before the cattle are placed in it. As soon as possible after the cattle are removed from a lot the female ticks and eggs present on the ground should be plowed under and the ground along the fence sprayed with crude petroleum or some other disinfectant to prevent any seed ticks which may hatch from getting beyond the area of the lot. Another valuable precaution will be to use for feed, as far as possible, the corn opposite or in advance of the lot in which the cattle are located, since this is less likely to harbor seed ticks.

The pasture will be free of ticks by November 1, and the cattle may then be returned there if desired. The herd may, however, be continued on field No. 3A as long after that date as the forage lasts, or, in case of a shortage of feed previous to November 1, it may be moved to either field No. 2 or 4, provided one of these is ready for pasturage. These fields may be used for fall and winter pasturage in any way that may be found desirable.

DIPPING, SPRAYING, AND HAND DRESSING.

Ticks upon cattle may be destroyed by using various "tickicides," such as oils, arsenic, etc. These may be applied in three ways, namely, by hand, by the use of spray pumps, and by means of the dipping vat.

Hand application is practicable only when a few animals are to be treated. The substances of value in this method are a mixture of lard and kerosene, cotton-seed oil, or a half-and-half mixture of cotton-seed oil and kerosene, and finally, crude petroleum, which in general has proved the most effective, although it has some drawbacks, chief of which are the difficulty of obtaining oil of the proper quality, its expense, its bulk, which makes its transportation costly, and the liability of injury to cattle when the treatment is applied in hot weather. Any of these may be applied with a mop or a good-sized paint brush, but unless great pains are taken this method of treatment is not thorough, and even at the best some portions of the body where ticks may be located will be missed.

Spraying is adapted for small-sized herds. The arsenical mixture or the crude petroleum or emulsions of the same may be applied by means of an ordinary pail spraying pump (fig. 12). There are also pumps on the market designed for making a temporary mechanical mixture of oil and water. Cotton-seed oil, or cotton-seed oil and kerosene in a half-and-half mixture, or crude petroleum, may be used in these pumps, and a 20 per cent mixture of any one of these will kill most of the ticks.

A large spraying machine which is now on the market and which has met with considerable favor in the treatment of large herds of cattle for mange is equally adapted to the application of remedies

for ticks, but on account of its expense is not likely to come into general use, and dipping in a vat is therefore on the whole the best and cheapest method of applying remedies when large herds are to be treated.

Farms and pastures may be freed of ticks by treating all cattle at regular intervals with an effective tick-destroying agent. If the treatment is applied with such success as to destroy all ticks

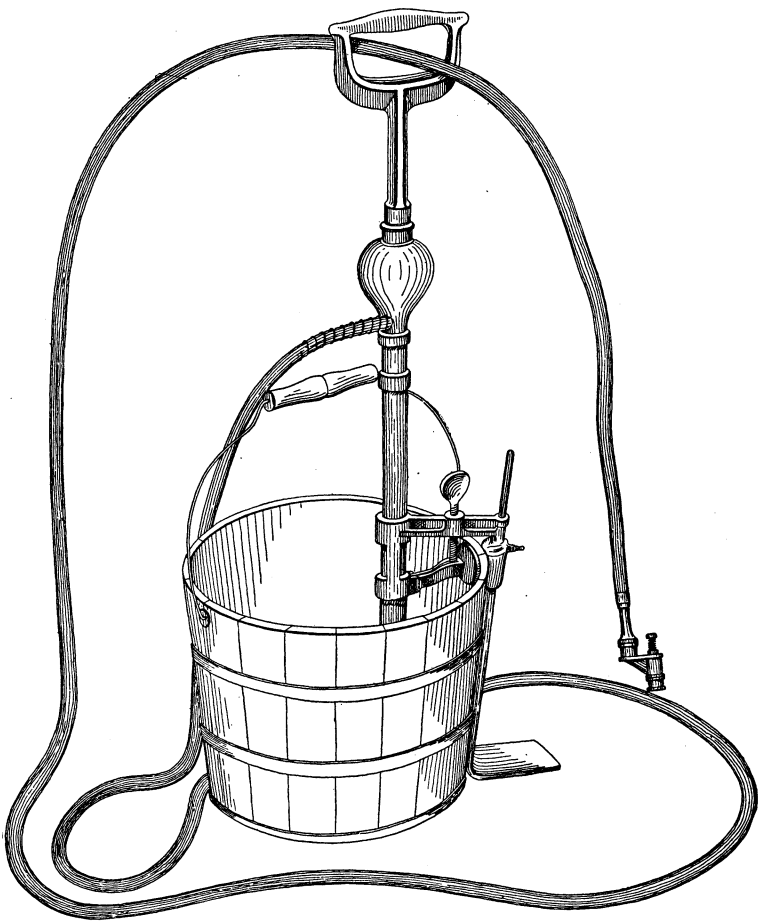

FIG. 12.—Pail spraying pump for small herds.

that reach the cattle from time to time, thus preventing any engorged females from dropping on the pasture after the beginning of the treatment, the pasture will become free of ticks after the same period of time has elapsed as would have been required if all animals had been excluded, beginning on the same date; that is, a perfectly successful treatment would be practically the same as the complete exclusion of the herd. The dates on which the starving

out of an infestation will be effected when begun at various times of the year have already been given in the table on page 11. In actual practice, however, the best treatment will in many cases not be absolutely successful, as some ticks will escape and may reinfest the pasture and thus prolong the time necessary to accomplish eradication. This method offers the advantage that the pasture may be used continuously.

Dips, their preparation and use.—*Crude petroleum.*—Various kinds of crude petroleum have been used with more or less success in destroying ticks. The heavier varieties of oil are very injurious to cattle. On the other hand, the very light oils are so volatile that their effects last but a short time, thus rendering them less efficient. The petroleum known as Beaumont oil, obtained from Texas wells, has given the best results. The best grade of this oil to use is one that has a specific gravity ranging from 22½° to 24½° Beaumé, containing 1¼ to 1½ per cent of sulphur, and 40 per cent of the bulk of which boils between 200° and 300° C. The oil may be applied by employing a spray pump or a dipping vat.

Animals that have been dipped in crude oil, especially during warm weather, should not be driven any great distance immediately afterwards, and should be provided with shade and an abundance of water. Unless these precautions are observed serious injury and losses may result.

Emulsions of crude petroleum.—In the majority of cases the best agent to use is an emulsion of crude petroleum, preferably Beaumont crude petroleum. The use of the emulsion makes the treatment less expensive than when the oil alone is used. The emulsion is not so injurious to the cattle and is almost if not quite as effective as the oil alone. The formula for preparing an emulsion of crude petroleum is as follows:

Hard soap	pound..	1
Soft or freestone water	gallon..	1
Beaumont crude petroleum	gallons..	4

Making 5 gallons of 80 per cent stock emulsion.

When a greater quantity of stock emulsion is desired, each of the quantities in the above formula should be multiplied by such a number as to furnish the required amount. For example, if it should be convenient to mix 10 gallons at one time, the quantities would have to be multiplied by 2, and if 15 gallons were desired, they would have to be multiplied by 3, and so on.

In preparing the emulsion the soap should be shaved up and placed in a kettle or caldron containing the required amount of water. The water should be brought to a boil and stirred until the soap is entirely dissolved. Enough water should be added to make up for the loss by

evaporation during this process. The soap solution and the required amount of oil are then placed in a barrel or some other convenient receptacle and mixed. The mixing may be effected by the use of a spray pump, pumping the mixture through and through the pump until the emulsion is formed. A convenient and time-saving method is to do the mixing in a barrel by first pouring in one part of hot soap solution and then four parts of crude petroleum and repeating this until the barrel is filled. The oil should be poured in with as much force as possible and the mixture stirred constantly with a long paddle until the oil is completely emulsified. The mixing is facilitated also by dipping up the mixture and pouring it back with a pail. If made properly, this stock emulsion is permanent and will keep indefinitely.

To prepare the stock emulsion for use, it is diluted with water to a 20 or 25 per cent emulsion. In order to obtain a 20 per cent emulsion of oil, it is necessary to use one part of the stock emulsion to 3 parts of water, and for a 25 per cent emulsion one part of stock emulsion to $2\frac{1}{5}$ parts of water. The stock emulsion is permanent, but the diluted emulsion does not remain uniformly mixed, so that if allowed to stand it should be thoroughly mixed by stirring before using. Only rain or freestone water should be used for diluting, and if this is not available, the water should be "softened" by adding a sufficient amount of concentrated lye, sal soda, or washing powder. Care should be observed in this process not to use an excess of these preparations.

An 80 per cent stock emulsion is on the market, and much time and labor can be saved by obtaining this instead of making the emulsion. To prepare it for use, it should be diluted in the same manner as indicated above for the homemade stock emulsion.

The arsenical dip.—This dip is used considerably on account of its cheapness and the ease with which it is prepared. In general it has proved very effective in destroying ticks, and is less likely than crude petroleum or emulsions of the same to injure cattle when dipping has to be done in hot weather. Some injury to the skin is, however, likely to occur when the arsenical mixture is used, and this injury, which will be so slight as to be scarcely noticeable if the cattle are properly handled, is liable to be serious if the cattle are driven any distance, especially if allowed to run while being driven within a week after treatment. The formula given below for making an arsenical dip is the one most commonly used in this country:

Sodium carbonate (sal soda)	pounds..	24
Arsenic trioxid (white arsenic)	do....	8
Pine tar	gallon..	1

Sufficient water to make 500 gallons.

If a stronger arsenical dip is desired, 10 pounds of arsenic may be used in place of 8 pounds, but in general the stronger solution should not be used. In warm weather particularly it is not advisable to use a solution stronger than that given in the above formula, if the animals are to be treated every two weeks.

In preparing the dip, a large caldron or galvanized tank is required for heating the water in which to dissolve the chemicals. Thirty or forty gallons of water should be placed in the caldron or tank and brought to a boil. The sodium carbonate is then added and dissolved by stirring. When this is accomplished, the arsenic is added and dissolved in a similar manner. The fire is then drawn and the pine tar added slowly in a thin stream and thoroughly mixed with the dip by constant stirring. This strong stock solution is diluted to 500 gallons before using.

If one desires, double or triple the amount of stock solution indicated above may be prepared at one time, provided a large enough vessel is available. In case a small vessel holding 20 to 25 gallons must be used, half of the stock solution indicated may be prepared. This will, however, consume so much more time in preparing large quantities that when possible it is advisable to provide a large vessel for dissolving the chemicals.

The stock solution, if it is to be used for dipping, may be placed in the vat as fast as it is prepared, or, if it is to be used for spraying, may be stored in barrels. The most convenient way of diluting the dip is to run the water into the vat through a hose or pipe. The capacity of the vat, if not known, should be calculated, and for convenience the water line marked at several places on the sides. After the exact amount of stock solution necessary to furnish diluted dip to fill the vat has been prepared and placed in the vat, all that is necessary is to allow water to flow into the vat until the surface of the dip reaches the marks made on the sides of the vat. For example, if the capacity of the vat is 2,000 gallons, then four times the amount of the stock solution necessary to make 500 gallons of the dip should be prepared, placed in the vat, and the latter filled with water to the 2,000-gallon mark.

When for any reason it is not convenient to follow the above method of diluting the dip, a stock solution may be prepared in which the quantity of ingredients for 500 gallons of diluted dip are dissolved in 50 gallons of water. Nine parts of water to one part of this stock solution will then give the proper dilution. This stock solution is found very convenient when small amounts of diluted dip are required from time to time for spraying cattle. Fifty gallons of the stock solution can be placed in a barrel and just the amount required each time taken out and diluted.

The diluted arsenical solution may be left in the vat and used repeatedly, replenishing with the proper quantities of water and stock solution when necessary. When not in use the vat should be tightly covered with a waterproof cover to prevent evaporation on the one hand and further dilution by rain on the other hand. Securely covering the vat when not in use also lessens the risk of accidental poisoning of stock and human beings.

Precautions in use of arsenic.—On account of the fact that arsenic is a dangerous poison, great care must be observed in making and using the arsenical dip. From the time the arsenic is procured from the druggist until the last particle of unused residue is properly disposed of, the most scrupulous care should be taken in handling this poison. Guessing at weights or measures or carelessness in any particular is liable to result in great damage, and not only may valuable live stock be destroyed, but human beings may lose their lives as well.

In the use of arsenical dips care should be taken not only to avoid swallowing any of the dip, but persons using the dip should also bear in mind the possibility of absorbing arsenic through cuts, scratches, or abrasions of the skin, and the possibility of absorbing arsenic by inhalation of vapors from the boiler in which the dip is prepared, or by the inhalation of the finely divided spray when the spray pump is used. It should be remembered that the absorption of even very small quantities of arsenic if repeated from day to day is liable ultimately to result in arsenical poisoning.

Cattle should always be watered a short time before they are dipped. After they emerge from the vat they should be kept on a draining floor until the dip ceases to run from their bodies; then they should be placed in a yard free of vegetation until they are entirely dry. If cattle are allowed to drain in places where pools of dip collect, from which they may drink, or are turned at once on the pasture, where the dip will run from their bodies on the grass and other vegetation, serious losses are liable to result. Crowding the animals before they are dry should also be avoided, and they should not be driven any considerable distance within a week after dipping, especially in hot weather. If many repeated treatments are given the cattle should not be treated oftener than every two weeks.

In addition to properly protecting vats containing arsenical dip when not in use, another precaution must be observed when vats are to be emptied for cleaning. The dip should not be poured or allowed to flow on land and vegetation to which cattle or other animals have access. The best plan is to run the dip in a pit properly protected by fences. The dip should also not be deposited where it may be carried by seepage into wells or springs which supply water used on the farm. The same precautions should be observed when animals are sprayed as when they are dipped.

Method of spraying.—Spraying is probably the most practicable and convenient way of treating cattle on the majority of farms. A

good type of pail spray pump (fig. 12), costing from $5 to $7, will be found satisfactory for treating small herds. About 15 feet of ⅜-inch high-pressure hose is required, and a type of nozzle furnishing a cone-shaped spray of not too wide an angle will be found satisfactory. A nozzle with a very small aperture should not be used, because the spray produced is too fine to saturate properly the hair and skin of the animals without consuming an unnecessary amount of time.

The animal to be sprayed should be securely tied to one of the posts of a board or rail fence, or, better still, when convenient, to the corner post in an angle of the fence. This will facilitate the spraying by preventing the animal from circling about to avoid the treatment, and will reduce the amount of help necessary. Every portion of the body should be thoroughly treated, special attention being given to

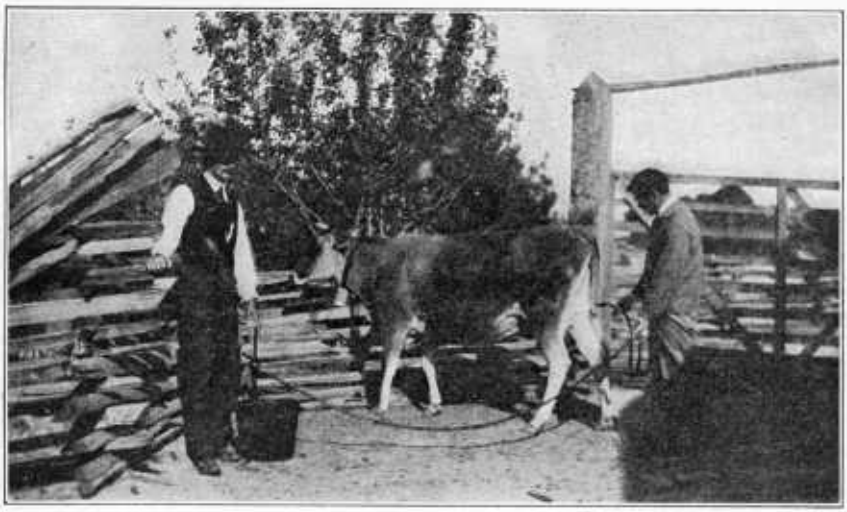

FIG. 13.—Spraying cow from pail with hand pump.

the head, dewlap, brisket, inside of elbows, inside of thighs and flanks, the tail, and the depressions at the base of the tail. Crude oil alone may be used, but in general a 20 to 25 per cent emulsion will be found more satisfactory.

All the cattle on the place should be sprayed every two weeks with this emulsion. The horses and mules should be kept free of ticks by picking or other means. If on account of heavy rains or other causes the oil disappears rather rapidly from the skin of the cattle, spraying should be carried out oftener. The interval should never be greater than two weeks, and spraying should not be discontinued simply because the ticks have become scarce or seem to have disappeared. This is a great temptation to the busy farmer, on account of the labor and expense incident to spraying, but in the long run it is short-

sighted economy, since in most cases it will increase the time necessary for eradication. If the ticks have entirely disappeared from the cattle during the fall and winter, this does not necessarily mean that eradication has been accomplished, because there may be present on the premises dormant seed ticks, live females, and eggs that will hatch with the coming of warm weather. It can not be determined until the next summer whether eradication has been entirely accomplished.

In localities where ticks commonly occur on cattle in considerable numbers during the winter time it will be advisable to continue spraying. In localities where ticks disappear or are present in very small numbers during the winter, the cattle should be inspected

FIG. 14.—Spraying cattle with hand pump from barrels on wagon.

carefully each week to remove and destroy any ticks that may be present. When warm weather comes, it will be well in all cases in which spraying has been discontinued during the winter to begin spraying and continue until it can be determined with certainty that eradication has been accomplished. The spraying should not be delayed until ticks show again in considerable numbers. One tick destroyed in the early spring will save the trouble of destroying thousands a few months later.

At the time of the first spraying all the large ticks should be removed by hand and destroyed. This will also be a very helpful thing to do at each spraying, when it is possible, because large females are likely to drop in a few hours after the cattle have been treated, and consequently may not suffer a great deal from the oil. The

farmer who has a small herd which is handled every day should be constantly on the lookout for large ticks. A few minutes spent each day in removing and destroying these ticks will materially aid any treatment employed to eradicate the tick. Eradication will also be much facilitated if at the beginning of the work all litter and manure are removed from stables, sheds, and yards that have been occupied by the cattle, and deposited on land where cattle are not permitted to run. After this is done the buildings should be thoroughly disinfected to destroy any eggs or ticks that may be there. For this purpose the following substances may be used:

1. A mixture made with not more than 1½ pounds of lime and one-fourth pound of pure carbolic acid to each gallon of water.

2. Any coal-tar creosote dip permitted by the United States Department of Agriculture in the official dipping of sheep for scabies, diluted to one-fifth of the maximum dilution specified for dipping sheep.

A spray pump should be used to apply the disinfectant, and the walls, floors, and various fixtures of the buildings should be thoroughly sprayed.

Specifications and materials for a dipping vat.—A vat constructed according to the accompanying plans will hold 2,088 gallons when filled to a depth of 5 feet.

Excavation.—Excavate for the vat, as shown by the drawings (fig. 15), to the proper depth. Level the bottom of the pit for the sills. After the vat is completed fill in around it, using the surplus earth to bring the grade at the sides of the vat a little above the natural grade and slope the surface away from the vat. Dig the holes required for all posts, etc.

Carpenter work.—The drawings show the vat constructed according to two methods. One method is to make the sides of 4 by 4 inch posts spaced about 3 feet apart and lined with 2 by 8 inch dressed, sized, and bevel-edged plank, using 20-penny spikes to fasten them to the posts and braces. All the joints are to be calked with oakum well driven in with a calking iron and pitched. The floor of the vat and the inclines are to be made of 2-inch plank with joints calked, the exit incline to have 2 by 4 inch cleats spiked to the plank flooring. The slide should have an angle of about 25° and should be covered with No. 16 galvanized iron.

The other method is to build the sides of the vat of 2 by 4 inch posts and 2 by 4 inch braces spaced about 16 inches on centers. The 2 by 4 inch posts and braces are to be lined with ⅞ by 8 inch tongued-and-grooved flooring, blind nailed at every bearing with 10-penny nails. All the joints are to be laid in white lead paste and the boards firmly driven up.

Lumber.—The lumber used in the construction of the vat must be thoroughly dried and seasoned stock, free from large and loose knots, straight grained, and free from sap.

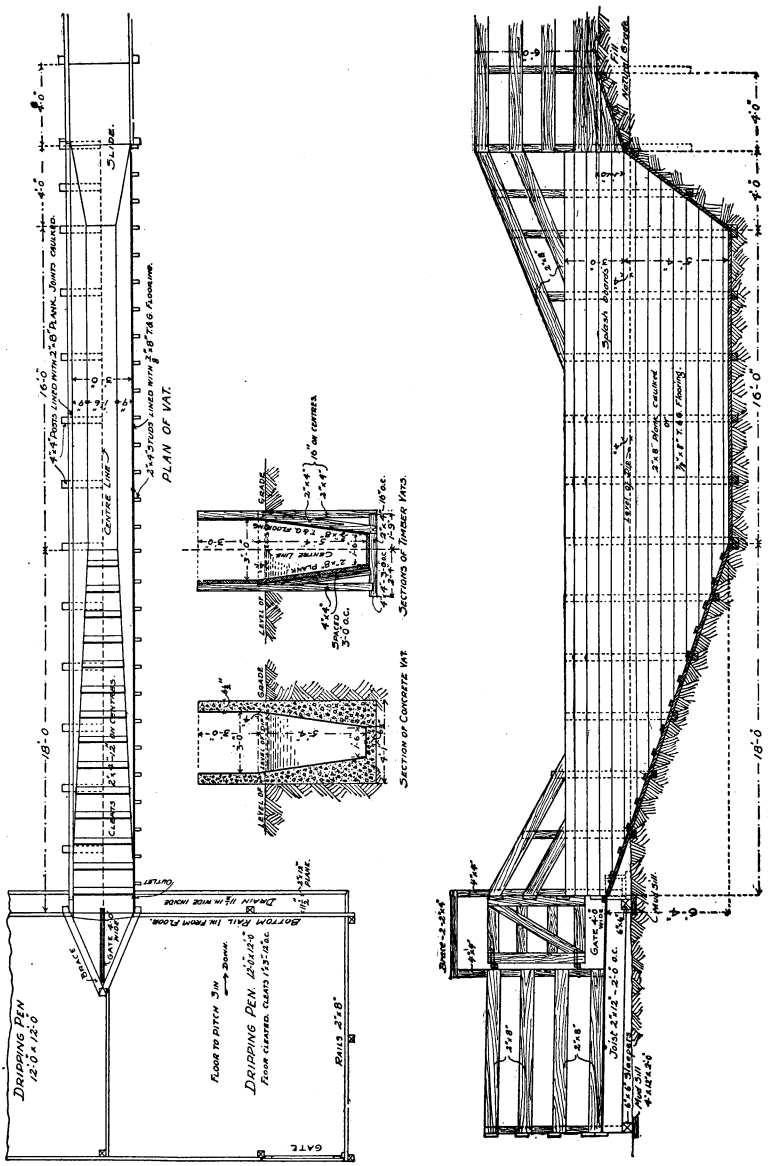

FIG. 15.—Drawings for wood or concrete dipping vat.

Gutters.—The gutters for the dripping pens should be made of sound stock, the bottom plank housed into the sides and ends, and the ends housed into the sides. All the joints are to be laid in white

lead paste and thoroughly nailed. Gutters are to have 3-inch fall in 11 feet.

Concrete vat.—The concrete vat should be made of concrete composed of 1 part by measure of good Portland cement, 3 parts of clean sharp sand, and 5 parts of broken rock, the broken rock to be not larger than will pass in any direction through a 2-inch ring. The rock should be washed free of dust. Concrete should be mixed wet and well tamped into place.

Bill of materials for vat and draining pens.—*Vat.*—Lumber for vat when constructed of 2-inch material and 4 by 4 inch posts:

Sills	8 pieces 4 by 4 inches by 10 feet long.
Posts	1 piece 4 by 4 inches by 16 feet long. 1 piece 4 by 4 inches by 14 feet long. 6 pieces 4 by 4 inches by 12 feet long. 5 pieces 4 by 4 inches by 10 feet long.
Braces	1 piece 4 by 4 inches by 16 feet long. 6 pieces 4 by 4 inches by 12 feet long. 1 piece 4 by 4 inches by 10 feet long. 1 piece 4 by 4 inches by 6 feet long.
Guards	2 pieces 2 by 8 inches by 18 feet long. 1 piece 2 by 8 inches by 16 feet long. 2 pieces 2 by 8 inches by 12 feet long. 1 piece 2 by 8 inches by 10 feet long.
Sides	18 pieces 2 by 8 inches by 20 feet long. 25 pieces 2 by 8 inches by 18 feet long. 2 pieces 2 by 8 inches by 16 feet long. 2 pieces 2 by 6 inches by 18 feet long. Dressed one side and two edges. Edges bevelled for calking.
Floor	3 pieces 2 by 10 inches by 20 feet long. 2 pieces 2 by 10 inches by 16 feet long. 1 piece 2 by 10 inches by 14 feet long. 1 piece 2 by 10 inches by 7 feet long. 1 piece 2 by 12 inches by 12 feet long. Dressed one side and two edges. Edges bevelled for calking.
Cleats	4 pieces 2 by 4 inches by 12 feet long.

Lumber for vat when constructed of flooring and 2 by 4 inch posts:

Sills	7 pieces 2 by 4 inches by 14 feet long.
Posts	28 pieces 2 by 4 inches by 18 feet long. 4 pieces 4 by 4 inches by 11 feet long.
Braces	15 pieces 2 by 4 inches by 12 feet long. 2 pieces 2 by 4 inches by 10 feet long. 2 pieces 2 by 4 inches by 16 feet long.
Guards	Materials the same as specified above.
Sides	550 feet b. m. $\frac{7}{8}$ by 8 inches tongue and grove flooring.
Floor	Materials the same as specified above.
Cleats	Materials the same as specified above.

Lumber for draining pens:

Mud sills	10 pieces 4 by 12 inches by 2 feet long (cedar or cypress).
Sleepers	4 pieces 6 by 6 inches by 12 feet long.
Joists	13 pieces 2 by 12 inches by 12 feet long.
Floor	360 feet b. m. tongue and grove flooring $\frac{7}{8}$ by 8 inches—12-foot pieces.
Cleats	265 linear feet 1 by 3 inches.
Gutters	Sides: 4 pieces 2 by 12 inches by 11 feet long (dressed). Bottom and ends: 2 pieces 2 by 12 inches by 12 feet (dressed). Bottom housed into sides and ends. Ends housed into sides. All joints calked and white leaded or pitched.
Posts	11 pieces 4 by 4 inches by 7 feet long. 2 pieces 4 by 4 inches by 8 feet long. 2 pieces 4 by 4 inches by 9 feet long.
Rails	2 pieces 2 by 8 inches by 18 feet long. 5 pieces 2 by 8 inches by 16 feet long. 18 pieces 2 by 8 inches by 12 feet long.
Braces	2 pieces 2 by 4 inches by 10 feet long.
Gates	7 pieces 1 by 6 inches by 12 feet long. 6 pieces 1 by 6 inches by 10 feet long.

Hardware for vat and draining pens:

4 pairs 12-inch heavy T hinges and screws.
4 wrought-iron hooks and staples.
1 pair wrought-iron hook hinges, 12-inch, wood screw hooks, and screws.
50 pounds 20-penny wire nails.
15 pounds 10-penny wire nails.
12 square feet No. 16 galvanized iron.

When vat is constructed of flooring and 2 by 4 posts, the following additional hardware will be required:

19 pounds 20-penny wire nails.
12 pounds 10-penny wire nails.

Material for concrete vat:

Concrete, 1 part Portland cement, 3 parts sand, 5 parts broken rock or gravel.
19 cubic yards broken rock or gravel.
18 cubic yards sand.
30 barrels Portland cement.

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